

11.—Microplankton from two samples from Gingin Brook No. 4 Borehole, Western Australia

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Abstract

Twenty-eight species of dinoflagellates assignable to 25 genera are recorded from Cretaceous strata of the Perth Basin, Western Australia. Two new genera are instituted. These are *Anthosphaeridium* (type species: *A. convolvuloides* Cookson and Eisenack n.sp.) and *Heterosphaeridium* (type species: *H. conjunctum* Cookson and Eisenack n.sp.). The following 6 new species are described: *Deflandrea lata*, *Aecdinium lordi*, *Aptecdinium cribosum*, *Hystichosphaera paradoxa*, *Anthosphaeridium convolvuloides*, and *Heterosphaeridium conjunctum*.

Introduction

The present paper is concerned with the microplankton content of two Cretaceous samples of Gingin Brook No. 4 Borehole, drilled by the Geological Survey of Western Australia. The borehole is situated at latitude 31° 19' 15" South, longitude 115° 32' 47" East, about 20 miles west of Gingin, a townsite some 45 miles north of Perth. The upper of these, from between 202 and 204 feet, represents the silty limestone unit, rich in foraminifera, which occurs between 180 and 215 feet (Sanders 1967). The lower sample, a glauconitic carbonaceous claystone, represents the interval between 404 and 414 feet.

The microplankton assemblages present in these two samples are so distinct from one another that they will be considered herein under separate headings. The samples and information concerning them were generously supplied by Mr. J. H. Lord, Director of the Geological Survey of Western Australia.

The holotypes will be housed in the palaeontological collection of the Geological Survey of Western Australia. Numbers prefaced by the letter F are registered numbers in that collection.

Systematic descriptions

1. Gingin Brook No. 4 Borehole between 202 and 204 feet

The age suggested for the silty limestone at this depth is Upper Cretaceous, either lowest Campanian or possibly Santonian (A. E. Cockbain in Sanders 1967, p. 30).

Dinoflagellata

Family DEFLANDREACEAE Eisenack

Genus *Deflandrea* Eisenack 1938

Deflandrea lata n.sp.

(Figure 1, A-C; holotype Figure 1A, F6621, paratype Figure 1C)

Occurrence. Gingin Brook silty limestone at 202-204 feet.

Description. Shell rather flat, without tabulation, broadly oval to nearly circular in outline, without a clearly defined girdle, occasionally a slight marginal indentation suggestive of a girdle has been present (Fig. 1A). Apex of shell with a small median and slightly concave

prominence; antapex narrower and more deeply concave than the apex with two short antapical horns.

Capsule widely separated from the wall of shell, nearly spherical to broadly oval in outline, its longer axis being at right angles to the longitudinal axis of the shell. Archeopyle small, intercalary in position, circular to oval in outline. Wall of both shell and capsule smooth and thin, that of the capsule being the thinner of the two.

Dimensions. Holotype—overall length 98 μ , overall width 84 μ , capsule c. 50 x 57 μ . Range—overall length c. 78-105 μ , overall width c. 76-97 μ ; capsule length c. 48-50 μ , width c. 48-75 μ .

Comment. Of the described species of *Deflandrea*, *D. lata* appears to come closest to *D. cretacea* Cookson 1956 originally described from three Upper Cretaceous deposits in the Nelson Bore, Victoria. It agrees with *D. cretacea* in the apparent absence of a girdle, but differs from this species in its rounded shape, the complete separation of the capsule from the shell and the greater prominence of the antapical projections.

Deflandrea cretacea Cookson 1956

(Figure 1D and E)

Deflandrea cretacea Cookson 1956, p. 104, Pl. 1, fig. 1-5.

Deflandrea cretacea Cookson; Cookson & Eisenack 1961, p. 71, Pl. 11, fig. 1, 2.

Deflandrea cretacea Cookson; Drugg 1967, p. 16, Pl. 2, fig. 17, 18.

Comment. The examples from the Gingin Brook silty limestone agree in general shape, form and type of ornamentation with those from the Victorian type locality, Nelson Bore at 6283, 6065 and 5304 feet. As in the latter, the degree of surface granulation varies considerably and in a few examples seems to be almost entirely absent (Fig. 1E).

The two examples referred to *D. cretacea* by Drugg (1967, Pl. 2, fig. 17, 18) differ from all the Australian examples of this species examined in the centralized position of the capsule. In this respect they are closer to the Western Australian species *D. lata* described above.

Deflandrea cf. verrucosa Manum 1963

(Figure 1F-H)

Deflandrea verrucosa Manum 1963, p. 60, Pl. 3, fig. 1-4.

Deflandrea verrucosa Manum; Manum & Cookson 1964, p. 9, Pl. 1, fig. 7.

Occurrence. Gingin Brook, Bore 4, 202-204 feet.

Comment. A few examples of the genus *Deflandrea* which approach *D. verrucosa* in the shape of the shell and the degree of coarseness and density of the ornament have been recovered from the Gingin Brook sample from Bore 4 at 202-204 feet. The resemblance to *D. verrucosa* is particularly evident in the specimen shown in Figure 1, F and G. In the second figured speci-

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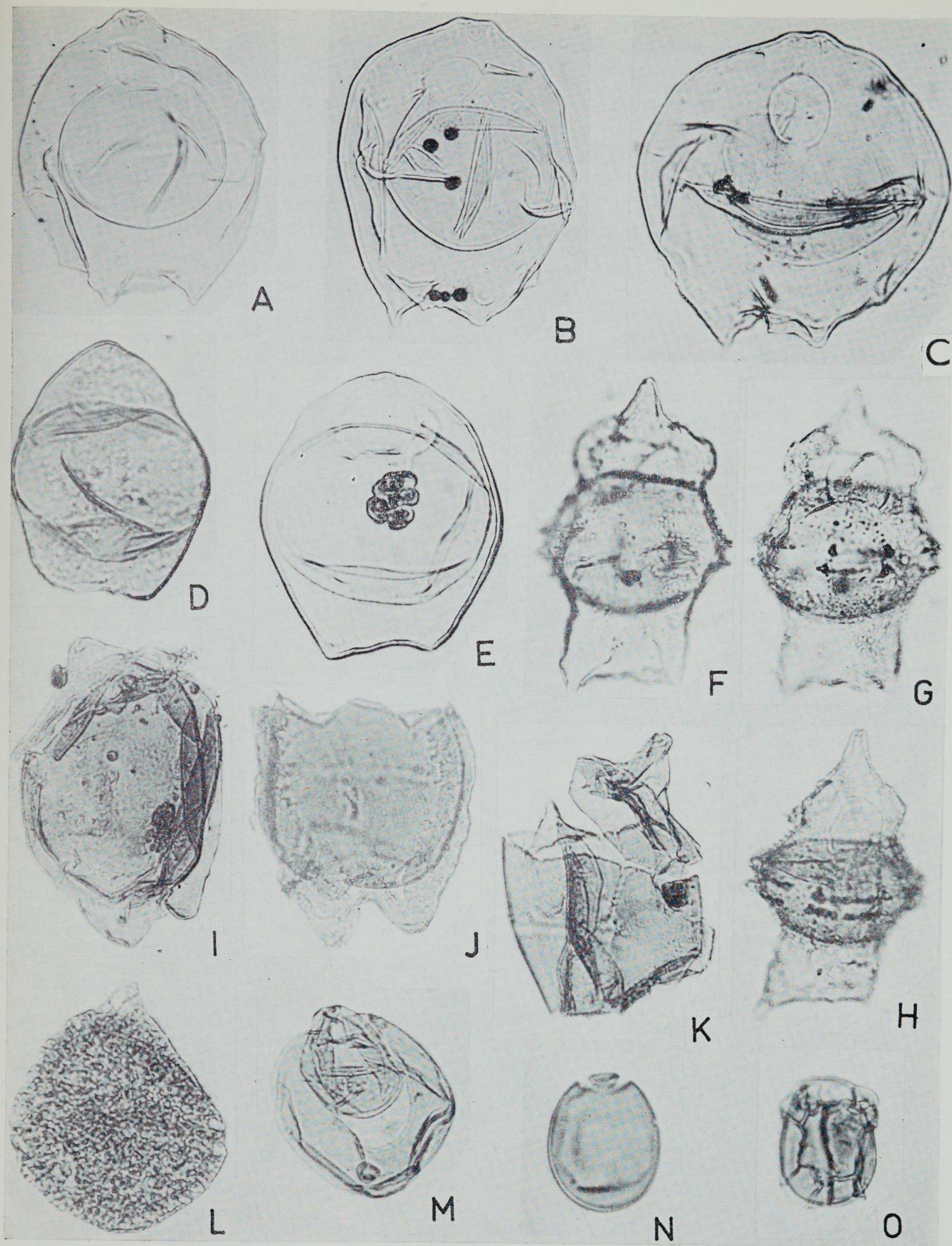


Figure 1. A, B, C.—*Deflandrea lata* n. sp. 1, ventral surface of holotype X c. 480, 2, 3, ventral surface of two other examples X c. 480. D, E.—*Deflandrea cretacea* Cookson & Eisenack X c. 650. F, G, H.—*Deflandrea* cf. *verrucosa* Manum X c. 480, 6, 7, ventral and dorsal views of the same example, 8, a second specimen X c. 480. I, J, K.—*Ascodinium lordi* n. sp. J. holotype X c. 480. I, K. two complete specimens X c. 480. L.—*Apteodinium cribosum* n. sp. X c. 650. M.—*Disphaeria macropyla* Cookson & Eisenack X c. 480. N.—*Palaeostomocystis chytra* Drugg X c. 700.—*Gillinia hymenophora* Cookson & Eisenack X c. 700.

men (Figure 1H) the ornament is finer and in side view the "granules" are pointed. However, in the illustration of the holotype of *D. verrucosa* (Figure 3A) a few slightly pointed "warts" are evident.

The Western Australian examples are smaller than those from Graham Island, Arctic Canada, ranging from 100-120 μ in length and 64-67 μ in width, as against a range in length in *D. verrucosa* of 112-135 μ and width of 65-87 μ . In view of such differences we think a comparison with, rather than a definite reference to *D. verrucosa* is preferable until more examples become available.

Genus *Ascodinium* Cookson & Eisenack 1960

Ascodinium lordi n.sp.

(Figure 1, I-K, holotype Figure 1J F6624)

Occurrence. Gingin Brook silty limestone between 202-204 feet.

Description. Shell longer than broad with slightly convex sides and three well-defined horns. The apical as well as the two antapical horns are short, broadly-based and somewhat triangular in outline with convex sides and rounded apices.

The internal capsule is oval in shape and almost fills the shell laterally, but does not extend into the horns. In the equatorial region of the capsule a light, straight-sided strip, c. 4 μ wide, which extends to its lateral limits, has usually been evident in the stained specimens used in this investigation.

The wall of the shell is thin and more or less granular. The wall of the capsule is somewhat thicker and smooth, except near the margins where, in most specimens, a more or less coarse, somewhat finely reticulate pattern is evident (Fig. 1J). The shell opens by the detachment of the whole apex along a straight or zig-zag line (Fig. 1J) suggestive of tabulation.

Of the fair number of specimens seen the two illustrated were the only complete ones found.

Dimensions. Holotype—length c. 90 μ overall width of 77 μ , width of capsule c. 62 μ . Complete Paratypes overall length c. 106-120 μ , overall width 68-80 μ ; opened shell c. 74-95 μ long.

Comment. We are aware that in the original diagnosis of the genus *Ascodinium* it was stated that "the shells open by the detachment of a circular part of the apical region, including the apex itself and a part of the ventral wall". In order to avoid the establishment of a new genus for this particular Gingin Brook type we propose to enlarge the description of the genus *Ascodinium* as follows: The shell opens by the detachment of the apex along a circular, straight or zig-zag line. The specific name is given in honour of Mr. J. H. Lord, Director of the Geological Survey of Western Australia.

Family *APTEODINIACEAE* Eisenack

Genus *Apteodinium* Eisenack 1958

Apteodinium cribosum n.sp.

(Figure 1L, holotype Figure 1L F6623)

Occurrence. Gingin Brook, silty limestone between 202 and 204 feet.

Description. Shell pear-shaped, divided by an indistinct girdle into a rounded hypotheca and a narrower epitheca with a short, blunt apical horn. The girdle though indistinct is c. 6 μ wide.

The wall of the shell is relatively thick especially in the antapical region, and seems to be perforated by small, densely arranged pores which give it a coarsely granular appearance in spite of its relatively smooth surface.

Dimensions. Holotype—62 μ long, 53 μ wide; Paratype—85 μ long, 60 μ wide.

Family *PSEUDOCERATIACEAE* Eisenack

Genus *Odontochitina* Deflandre 1935

Odontochitina cribropoda Deflandre & Cookson 1955

(Figure 2, A-C)

Odontochitina cribropoda Deflandre & Cookson 1955 p. 292 Pl. 3, fig. 7-11.

Comment. Examples referable to *O. cribropoda*, previously recorded from Upper Cretaceous deposits at Gingin, W.A. and the Nelson Bore, Victoria at 5782 feet, which occur relatively frequently in the Gingin Brook silty limestone between 202 and 204 feet, show a rather high degree of variability. Except for one imperfectly presented complete example and a single detached apical horn, all have been represented by opened shells.

Constant features of the Gingin Brook examples are 1) the difference in length of the two antapical horns, 2) the presence in them of cylindrical unperforated proximal portions and somewhat broadened perforated distal portions, 3) the pointed character of the antapical horns. Variable characters are 1) the degree of divergence of the antapical horns from nearly parallel to widely divergent, 2) the proportion of the perforated to the unperforated portions, 3) the breadth of the perforated to that of the unperforated parts, which is usually cylindrical and 4) the density and coarseness of the perforation.

Dimensions. Apical horn (complete) 158 μ long, antapical horns 52-162 μ long.

Odontochitina sp.

(Figure 2D, F6624)

Comment. A form which apparently represents a new species of *Odontochitina* has occurred regularly in the preparations of Gingin Brook silty limestone between 202 and 204 feet. Twelve specimens have been mounted and examined but, since none of them has been complete, we are refraining from raising this form to specific rank.

The two main features which distinguish this form from *O. cribropoda* Deflandre & Cookson 1955, with which it is associated, are 1) the antapical horns which are inserted at the corners of the hypotheca are long, widely divergent, thick walled and sometimes striated, and 2) the perforation of the thin-walled portions is restricted to the extreme ends of the horns and is frequently partially or completely missing.

Dimensions. Maximum length of horns 147 μ .

Family *HYSTRICHOSPHAERACEAE* O. Wetzel emend Evitt

Genus *Hystrichosphaera* O. Wetzel 1933 emend. Deflandre 1937

Hystrichosphaera cf. *wetzelii* Deflandre 1937 (Figure 2E-F)

Hystrichosphaera wetzelii Deflandre 1937, p. 65, Pl. 11, fig. 8.

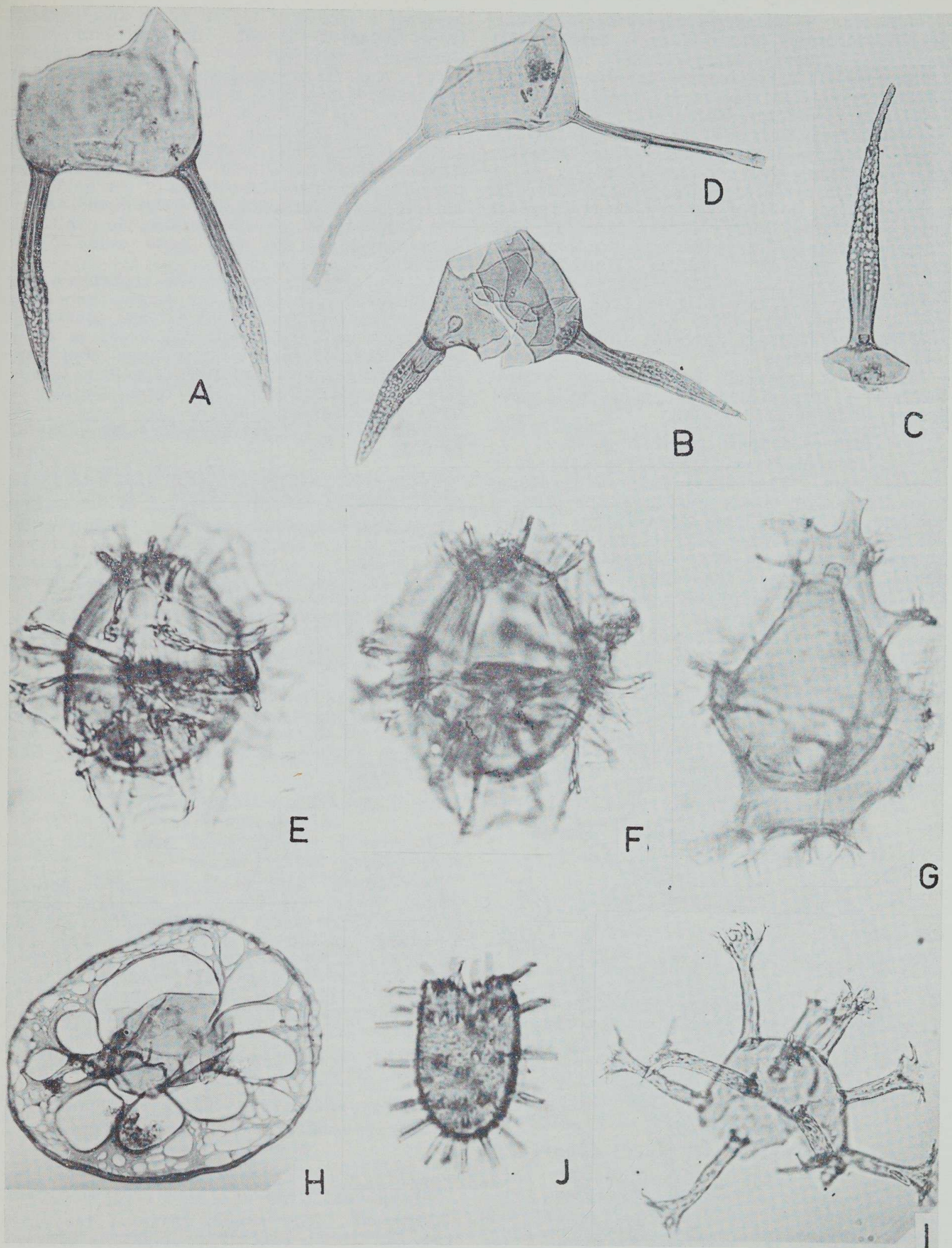


Figure 2. A, B, C.—*Odontochitina cribropoda* Deflandre & Cookson 1, 2, hypotheca of two examples 1, X c. 330, 2, X c. 260, 3, portion of epitheca with apical horn X c. 260. D.—*Odontochitina* sp. hypotheca X c. 260. E, F.—*Hystrichosphaera* cf. *Wetzelii* Deflandre, dorsal and ventral surface X c. 700. G.—*Hystrichosphaera paradoxa* n. sp. side view X c. 670. H.—*Aiora fenestrata* (Deflandre & Cookson) X c. 470. I.—*Tanyosphaeridium isocalamus* (Deflandre & Cookson) X c. 650 J.—*Oligosphaeridium* sp. X c. 340.

Comment. The single specimen obtained from the Gingin Brook silty limestone between 202 and 204 feet herein compared with *Hystrichosphaera wetzeli* Deflandre has, like this species, a tabulation close to that of *H. furcata* (Ehrenberg) and *H. ramosa* (Ehrenberg). However, it is distinct from both of these species in that, as in *H. wetzeli*, its fields are bounded by relatively high membranes with concave edges.

The Gingin Brook specimen, lying as it does in a dorsoventral position, shows both the ventral fields and the archeopyle on the dorsal surface. The membrane outlining the fields are somewhat lower than those of *H. wetzeli*. Unfortunately the exact tabulation of the ventral surface of the holotype of *H. wetzeli* is not fully known so that a definite connection between this species and the Gingin Brook specimen cannot, at present, be established.

Dimensions. Overall length 70 μ ; overall width 57 μ ; central body 48 μ long, 38 μ wide; borders of fields 10-15 μ high.

Hystrichosphaera paradoxa n. sp.
(holotype Figure 2G, F6625; Figure 3)

Description. The single example recovered from the Gingin Brook silty limestone between 202 and 204 feet is lying sideways on. In this position it is somewhat pear-shaped in that the antapical portion is more rounded than the apical. The apex of the central body bears a small cylindrical prominence, while its surface

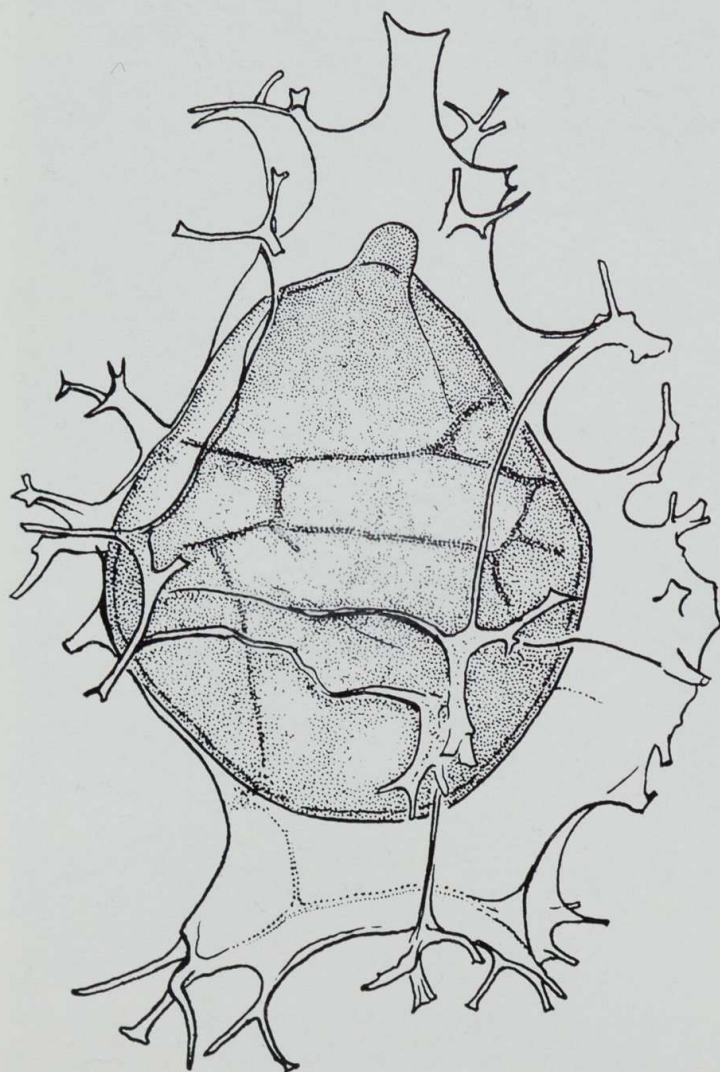


Figure 3.—*Hystrichosphaera paradoxa* n.sp. (x1053).

supports a system of ledges which approximates in arrangement to those of *Hystrichosphaera furcata* (Ehrenberg) and *H. ramosa* (Ehrenberg). A girdle divided into fields is evident. In the apical region high membranous ledges form a hollow "cap" which surmounts the apex of the central body and ends in a short median projection bearing short, slightly forked appendages at about half its length. Similar appendages are also present at the corners of the fields and on the ledges, for example of the girdle and at the basal parts of the archeopyle which is recognisable on the left hand side of the specimen.

On the side opposite to the archeopyle and commencing just above the girdle there is a system of membranes which extends downwards forming a wide outgrowth, the edges of which also bear short forked appendages. Both the apical and antapical outgrowths seem to be six-sided; the dorsal side (left hand) appears to have no such membranes.

Dimensions. Central body 50 x 42 μ ; overall 94 x 64 μ .

Family HYSTRICHOSPHAERIDIACEAE Evitt
Genus *Oligosphaeridium* Davey & Williams 1966
Oligosphaeridium pulcherrimum (Deflandre & Cookson 1955)

(Figure 4E)

Hystrichosphaeridium pulcherrimum Deflandre & Cookson 1955, p. 270, Pl. 1, fig. 8, text fig. 21.

Hystrichosphaeridium pulcherrimum Deflandre & Cookson; Valensi 1955, p. 592, Pl. 4, fig. 1.

Oligosphaeridium pulcherrimum (Deflandre & Cookson) Davey & Williams 1966, p. 75, Pl. 11, fig. 5.

Comment. The specimen from the Gingin Brook silty limestone between 202 and 204 feet agrees in all characters with the holotype from a Lower Cretaceous deposit at Onepah, New South Wales.

Oligosphaeridium sp.

(Figure 2I, F6626)

Occurrence. Gingin Brook Bore 4, silty limestone between 202-204 feet.

Description. The single, well characterized though incomplete specimen recovered seems referable to the genus *Oligosphaeridium*. It has a smooth, apparently single-layered wall and ten long, tubular appendages with funnel-shaped ends, the edges of which are fringed with finely branched fibrils. The surface of the appendages is ornamented with small thickenings which tend to be arranged in longitudinal rows.

Dimensions. Shell—diameter c. 68 μ ; appendages c. 56 μ long; overall diameter c. 170 μ .

Genus *Tanyosphaeridium* Davey & Williams 1966
Tanyosphaeridium isocalamus (Deflandre & Cookson 1955)

(Figure 2J)

Hystrichosphaeridium isocalamus Deflandre & Cookson 1955, p. 272, Pl. 2, fig. 7, 8, Fig. 30-35.

Comment. The single specimen recovered from the Gingin Brook silty limestone between 202 and 204 feet agrees closely with the type from a ?Lower Cretaceous deposit at Onepah Station, New South Wales. Its surface is densely granular and the apices of the appen-

dages sharply truncate, in contrast to those of *T. variecalamum* Davey & Williams (1966) from the Upper Cretaceous (Cenomanian) England.

Genus *Anthosphaeridium* n. gen.

Description. Shell typically spherical, completely covered with short, densely arranged, striated, funnel-shaped appendages.

Type species: *Anthosphaeridium convolvuloides* n. sp.

Anthosphaeridium convolvuloides n. sp.

(Figure 4A-D; holotype Figure 4A, F6627)

Occurrence. Gingin Brook No. 4 Borehole, silty limestone between 202-204 feet.

Description. Shell small, circular in outline with a thin, finely granular wall. Appendages very numerous, apparently hollow throughout their length, consisting of a short, gradually widening tubular stalk and a widely open funnel-shaped terminal portion, the wall of which is longitudinally striated (Fig. 4B-D). The appendages resemble the flowers of *Convolvulus* sp. in shape, hence the choice of the specific name.

Dimensions. Holotype—shell c. 44 μ ; overall diameter c. 70 μ . Range—shell c. 40-50 μ , overall diameter c. 56-80 μ .

Comment. *A. convolvuloides* is a readily recognisable type in spite of the fact that, owing to the thinness of the wall, it is liable to distortion as the result of the treatment received.

Genus *Heterosphaeridium* n. gen.

Description. Shell circular in outline with numerous solid appendages of varying widths in one and the same specimen and opening by the removal of the whole apex along a straight line.

Type species: *Heterosphaeridium conjunctum* n. sp.

Heterosphaeridium conjunctum n. sp.

(Figure 4G-H; holotype Figure 4H, F6628)

Occurrence. Gingin Brook No. 4 Borehole, silty limestone between 202 and 204 feet.

Description. Shell circular in outline, wall covered with numerous simple or variously divided appendages of equal length but very variable width, which narrow distally from slightly broadened bases. The apices of the appendages are either simple, branched or fringed, and their bases are frequently joined by relatively broad surface ridges which delimit relatively large polygonal areas. The shell opens by the detachment of the whole apex along a straight line. The wall of the shell is finely and densely granular.

Dimensions. Holotype—shell c. 114 μ long and c. 128 μ broad; overall c. 133 μ x c. 157 μ . Range—width of shell c. 70 μ —133 μ , overall width c. 125 μ —c. 170 μ .

Family Uncertain

Genus *Gillinia* Cookson & Eisenack 1960

Gillinia hymenophora Cookson & Eisenack 1960

(Figure 1, O)

Gillinia hymenophora Cookson & Eisenack 1960, pp. 11, 12, Pl. 3, fig. 4-6.

Comment. This readily recognizable form has appeared regularly in preparations of the portion of the Gingin Brook silty limestone

examined. The specimens agree exactly with those from the Western Australian Upper Cretaceous (Upper Turonian to Upper Senonian) localities listed in the original description.

Group *ACRITARCHA* Evitt 1963

Subgroup *DISPHAEROMORPHITAE*

Genus *Disphaeria* Cookson & Eisenack 1960

Disphaeria macropyla Cookson & Eisenack 1960

(Figure 1M)

Disphaeria macropyla Cookson & Eisenack 1960, p. 11, Pl. 3, fig. 13, 14.

Comment. Several examples which agree with *D. macropyla*, originally described from the Turonian Gearle Siltstone, Rough Range Bore 1 and from the Molecap Greensand Western Australia, have been recovered from the Gingin Brook silty limestone between 202 and 204 feet.

Subgroup Uncertain

Genus *Aiora* Cookson & Eisenack

Aiora fenestrata (Deflandre & Cookson 1955)

(Figure 2H)

Cannosphaeropsis fenestrata Deflandre & Cookson 1955, p. 283, Pl. 3, fig. 2.

Aiora fenestrata (Deflandre & Cookson) Cookson & Eisenack 1960, p. 9, Pl. 5, fig. 17, 18.

Aiora fenestrata (Deflandre & Cookson) Wilson 1967, p. 69, fig. 2c, 37, 38.

Comment. Several well preserved examples of *A. fenestrata* have been recovered from the Gingin Brook silty limestone between 202 and 204 feet. In one of these a faint suggestion of the archcopyle demonstrated by Wilson 1967 as occurring in Antarctic Lower Tertiary examples was observed, but not clearly enough for exact comparison and photographic illustration. Otherwise the Gingin Brook examples have been well preserved and in close agreement with those recorded from Upper Cretaceous deposits in the Gingin area (Molecap Greensand) and Rough Range South No. 1 bore between 2500-2511 ft. in Western Australia.

Genus *Palaeostomocystis* Deflandre

Palaeostomocystis chytra Drugg

(Figure 1N)

Palaeostomocystis chytra Drugg 1967, p. 35, Pl. 6, fig. 12.

Comment. Specimens which agree closely with *P. chytra* are relatively numerous in the Gingin Brook silty limestone between 202 and 204 feet. They agree in shape and size with those from the Upper Moreno Formation of California. They are oval in shape with a smooth surface and concave opening. The "lid" often attached, as in the figured example, is considerably smaller than the subsequent opening.

Dimensions. Figured specimen c. 32 x 25 μ , opening c. 12 μ .

II. Gingin Brook No. 4 Borehole, core 2 between 404 and 414 feet

The glauconitic carbonaceous claystone at the above depth has a rich microplankton content which differs completely from that of the above described silty limestone of core 2 at 202 to 204 feet. No attempt has been made to identify all the forms present. However, enough of them have been studied to indicate that the age of

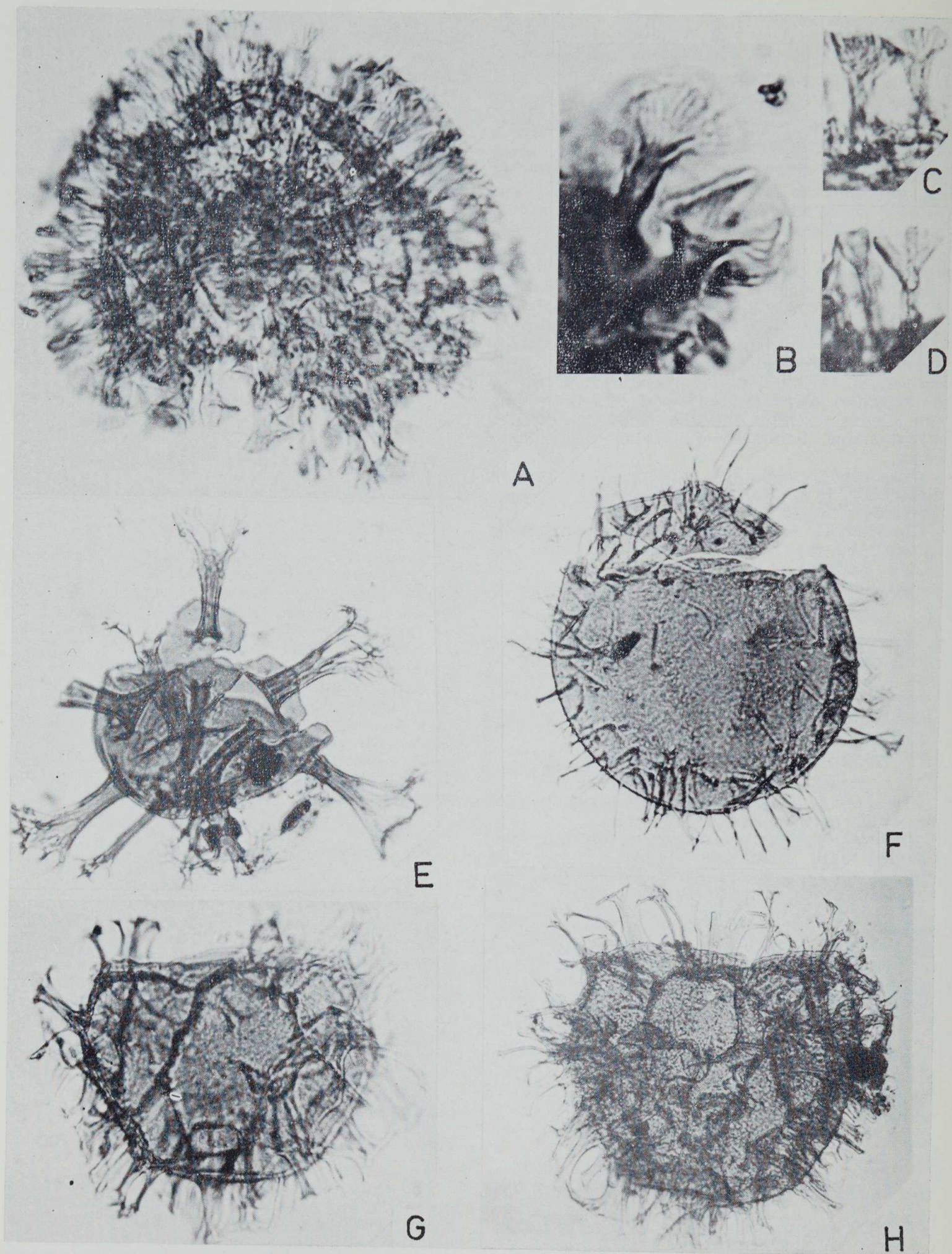


Figure 4. A, B, C, D.—*Anthosphaeridium convolvuloides* n. sp. 1, holotype X c. 1140, 2-4, appendages showing longitudinal striations, 2 X c. 1800, 3, 4 X c. 1400. E.—*Oligosphaeridium pulcherrimum* (Deflandre & Cookson) X c. 470. F.—*Cyclonephelium disinctum* Cookson & Eisenack X c. 500. G, H.—*Heterosphaeridium conjunctum* n. sp. 19, paratype X c. 500, 8, holotype X c. 500.

the deposit as a whole approximates to Mid-Cretaceous. (B. Ingram in Sanders 1966.)

Dinoflagellata

Family GONYAULACACEAE Lindemann

Genus *Gonyaulacysta* Deflandre 1964

Gonyaulacysta edwardsi (Cookson & Eisenack)

(Figure 5A and B)

Gonyaulax edwardsi Cookson & Eisenack 1958, p. 32, Pl. 3, fig. 45, fig. 7.

Gonyaulax edwardsi Cookson & Eisenack; Cookson & Hughes 1964, p. 43, Pl. 5, fig. 9.

Comment. *Gonyaulacysta edwardsi* has occurred in relatively large numbers in the preparation of the Gingin Brook No. 4 bore, core 2 at 404-414 feet. It was originally recorded from a number of Western Australian Cretaceous deposits, the age of which ranges from Albian, for example Seismic shot holes B2 at 230 feet and L8 at Gingin, to Cenomanian to Lower Turonian in the Gearle Siltstone (upper part), Wapet's Rough Range Well, 5 at 1570 feet. It was not found in any of the preparations of the Gingin Brook silty limestone core 1, 202-204 feet.

G. edwardsi has also been recorded from Albian to Mid-Cretaceous deposits near Cambridge, England (Cookson & Hughes 1964).

Gonyaulacysta cassidata (Eisenack & Cookson)

(Figure 5C)

Gonyaulax helicoidea subspecies *cassidata* Eisenack & Cookson 1960, p. 3, Pl. 1, fig. 5, 6.

Gonyaulax cassidata Eisenack & Cookson; Cookson & Eisenack 1962, Pl. 2, fig. 11, 12.

Gonyaulax cassidata Eisenack & Cookson. Cookson & Hughes 1964, p. 42, Pl. 5, fig. 10, 11.

Comment. The figured specimen was recovered from the Gingin Brook No. 4 bore at 404-414 feet. It has all the characters of the type and subsequent examples recorded from Australian Aptian—Cenomanian deposits (Cookson & Eisenack 1962). *G. cassidata* has also been recorded from Mid-Cretaceous beds, near Cambridge, England (Cookson & Hughes 1964). Sargeant (1966) regards one of the two Cambridge specimens (Pl. 5, fig. 11) as a representative of *Psaligonyaulax deflandrei* Sargeant.

Family DEFLANDREACEAE Eisenack

Genus *Scriniodinium* Klement 1957

Scriniodinium galeatum Cookson & Eisenack 1960

(Figure 5D)

Scriniodinium galeatum Cookson & Eisenack 1960, p. 3, Pl. 1, fig. 16-18.

Comment. Several specimens of *S. galeatum* have been recovered from the Gingin Brook bore 4, core 2, 404-414 feet. They agree in general features with those previously recorded from the Albian to Cenomanian Lower Gearle Siltstone, Rough Range South No. 1 bore, core 69 (2748-2758 feet). Upper Albian to Cenomanian deposit north of Gingin, Wapet's seismic shot hole B1, at 210 feet, and the Brickhouse Bore at 1210 feet, probably Cenomanian.

Genus *Ascodinium* Cookson & Eisenack 1960

Ascodinium acrophorum Cookson & Eisenack 1960

(Figure 5K)

Deflandrea acuminata Cookson & Eisenack 1958, p. 27, Pl. 4, fig. 8.

Ascodinium acrophorum Cookson & Eisenack 1960, p. 5, Pl. 1, fig. 19, 20.

Comment. Specimens of this species which agree with those from the ?Upper Albian to to Cenomanian Osborne Formation, Subiaco Bore, Western Australia at 358 feet and the Fremantle Traffic Bridge bore 5, at 100 feet, have occurred occasionally in the Gingin Brook sample from Bore 4, core 2 at 404-414 feet.

Ascodinium parvum (Cookson & Eisenack 1958))

(Figure 5J)

Deflandrea parva Cookson & Eisenack 1958, p. 28, Pl. 4, fig. 12.

Ascodinium parvum (Cookson & Eisenack); Cookson & Eisenack 1960, p. 5, Pl. 1, fig. 23-25.

Comment. *A. parvum*, which has been recorded from a relatively large number of Western Australian Albian to Cenomanian deposits (Cookson & Eisenack 1960), has occurred in small numbers in the Gingin Brook No. 4 sample from core 2, at 404-414 feet.

Family PSEUDOCERATIACEAE Eisenack

Genus *Pseudoceratium* Gocht 1957

Pseudoceratium ludbrookii (Cookson & Eisenack 1958)

(Figure 5E)

Ceratocystidicpsis ludbrookii Cookson & Eisenack 1958, p. 52 Pl. 5, fig. 7, 8.

Pseudoceratium ludbrookii (Cookson & Eisenack); Eisenack 1961, p. 299.

Comment. *P. ludbrookii* has been recorded from several deposits in Western Australia, and one from South Australia, all of which are believed to be of Albian age. Several examples have been recovered from the Gingin Brook sample from Bore 4, core 2, between 404 and 414 feet, but in all the apical portion of the shell has been missing.

Family APTEODINIACEAE Eisenack

Genus *Apteodinium* Eisenack 1958

Apteodinium maculatum Eisenack & Cookson 1960

(Figure 5F)

Apteodinium maculatum Eisenack & Cookson 1960, p. 4, Pl. 2, fig. 1-3.

Comment. *Apteodinium maculatum*, readily recognizable by the groups of circular thickenings that occur on the surface of the archeopyle and other areas, has occurred in the Gingin Brook sample from Bore 4 between 404 and 414 feet. *A. maculatum* was originally recorded from the Aptian Roma Formation, North Queensland, Batavia Downs Well between 45-49 feet, and Albian deposits such as the Lower Gearle Siltstone in Western Australia, Rough Range Bore No. 7 at 2,360-2,375 feet, and in the Santos Oodnadatta Bore, South Australia at 87-327 feet.

Family GYMNODINIACEAE Lemmermann

Genus *Diconodinium* Eisenack & Cookson 1960

Diconodinium dispersum (Cookson & Eisenack 1958)

(Figure 5H)

Palaeohystrichophora dispersa Cookson & Eisenack 1958, p. 39, Pl. 10, fig. 12, 14.

Diconodinium dispersum (Cookson & Eisenack) Eisenack & Cookson, 1960, p. 3.

Comment. *D. dispersum* was originally described from two deposits, one near Gingin, W.A. from Seismic Shot Hole B2 at 230 feet, the

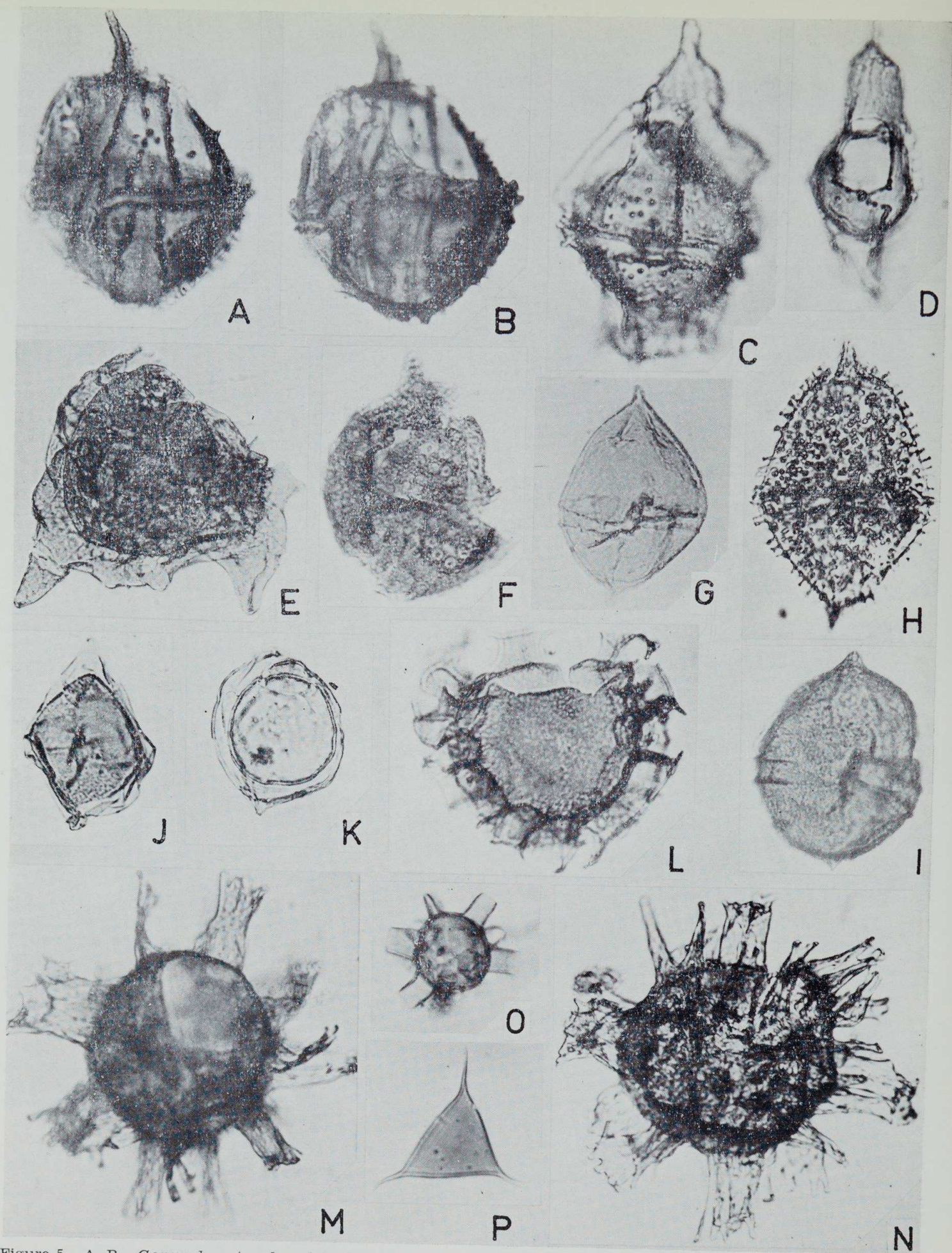


Figure 5. A, B.—*Gonyaulacysta edwardsi* (Cookson & Eisenack) dorsal and ventral surfaces X c. 300. C.—*Gonyaulacysta cassidata* (Cookson & Eisenack) X c. 680. D.—*Scriniodinium galeatum* Cookson & Eisenack X c. 430. E.—*Pseudoceratium ludbrookii* Cookson & Eisenack X c. 330. F.—*Apteodinium maculatum* Eisenack & Cookson X c. 470. G.—*Diconodinium glabrum* Eisenack & Cookson X c. 470. H.—*Diconodinium dispersum* Cookson & Eisenack X c. 300. I.—*Diconodinium inflatum* Eisenack & Cookson X c. 470. J.—*Ascodinium parvum* Cookson & Eisenack X c. 300. K.—*Ascodinium acrophorum* Cookson & Eisenack X c. 300. L.—*Cyclonephelium acrophorum* Cookson & Eisenack X c. 300. M, N.—*Cordosphaeridium chimaera* n. sp. X c. 470. O.—*Lithosphaeridium siphoniphorum* (Cookson & Eisenack) X c. 400. P. *Veryhachium reductum* Deunff X c. 700.

other from King Edward Street Bore, near Perth, W.A. between 265 and 925 feet, both of which are believed to be of Albian age. Later, Eisenack and Cookson (1960) recorded a third occurrence, namely from the Subiaco Bore, W.A. at 358 feet. The examples from the Gingin Brook No. 4 Borehole between 404 and 414 feet agree completely with the earlier examples.

Diconodinium glabrum Eisenack & Cookson
1960

(Figure 5G)

Diconodinium glabrum Eisenack & Cookson
1960, p. 3, Pl. 1, fig. 11.

Comment. Examples which agree with *D. glabrum*, originally recorded from Albian deposits in the Gingin area (Moora Bore 86-170 feet), the Lower Gearle Siltstone, Wapet's Rough Range Bore No. 7 at 2360-2375 feet, and the Santos Oodnadatta Bore, S.A. at 237 and 367 feet, have been recovered from the Gingin Brook sample between 404-414 feet.

Diconodinium inflatum Eisenack & Cookson
1960

(Figure 5I)

Diconodinium inflatum Eisenack & Cookson
1960, p. 4, Pl. 1, fig. 12, 13.

Comment. A few specimens have been recovered from the Gingin Brook borehole at 404-414 feet which agree in general form and structure with those from the ?Upper Albian to Cenomanian sample from Wapet's Seismic Shot Hole B1 at 220 feet, north of Gingin, W.A.

Family Uncertain

Genus *Canninginopsis* Cookson & Eisenack 1962
Canninginopsis denticulata Cookson & Eisenack
1962

Canninginopsis denticulata Cookson & Eisenack
1962, p. 488, Pl. 1, fig. 16-19.

Comment. *C. denticulata*, a widespread Mid-Cretaceous Western Australian type, occurs in the Gingin Brook Bore 4, core 2, between 404 and 414 feet. The specimens were rather crumpled and not suitable for illustration.

Family HYSTRICHOSPHAERIDIACEAE Evitt

Genus *Hystrichosphaeridium* Deflandre 1937

Hystrichosphaeridium stellatum Maier 1959

(Figure 6J)

Hystrichosphaeridium stellatum Maier 1959, p. 320, fig. 3, 4.

Hystrichosphaeridium stellatum Maier; Cookson & Eisenack 1962, p. 492, Pl. 4, fig. 14.

Hystrichosphaeridium stellatum Maier; Cookson & Hughes 1964, p. 48, Pl. 9, fig. 11.

Hystrichosphaeridium stellatum Maier; Manum & Cookson 1964, p. 4, Pl. 3, fig. 4.

Hystrichosphaeridium stellatum Maier; Drugg 1967, p. 27, Pl. 4, fig. 11.

Comment. The single specimen of this type recovered from the Gingin Brook No. 4 Borehole deposit between 404 and 414 feet agrees closely with those recorded by Cookson and Eisenack (1962) from a number of Western Australian Albian deposits, including one from a bore core from the neighbourhood of Gingin. It also agrees with the specimen figured by Cookson and Hughes (1964) from the Mid-Cretaceous Cambridge Greensand and the one figured by Drugg (1967) from the Danian of

California. Whether or not the Cretaceous examples are specifically distinct from Maier's Tertiary form only future work will decide.

Hystrichosphaeridium ferox Deflandre 1937

(Figure 6K)

Hystrichosphaeridium ferox Deflandre 1937, p. 72, Pl. 14, fig. 3, 4.

Hystrichosphaeridium ferox Deflandre; W. Wetzel 1952, p. 402, Pl. A, fig. 13, fig. 20.

Hystrichosphaeridium ferox Deflandre; Eisenack; 1958, p. 401, Pl. 27, fig. 1, 2.

Hystrichosphaeridium ferox Deflandre; Gocht 1959, p. 71, Pl. 4, fig. 1.

Baltisphaeridium ferox (Deflandre) Downie & Sargeant 1963, p. 89-92.

Non *Baltisphaeridium ferox* (Deflandre) Cookson & Hughes 1964, p. 55, Pl. 10, fig. 11.

Occurrence. Gingin Brook Bore No. 4, 404-414 feet.

Comment. Specimens which, although somewhat larger, agree closely with the example described and figured by Deflandre (1937) under the name *Hystrichosphaeridium ferox* have occurred in the Gingin Bore sample.

Recently, with the permission of Professor Deflandre, it has been suggested that this species be transferred to the genus *Hystrichokolpoma* Klumpp (Williams and Downie 1966, p. 181). Since, in the original description of *Hystrichokolpoma*, the presence of a distinctly larger antapical process was specified, a feature absent from the type of *H. ferox* and our Australian representatives, we are leaving the question open and using the original designation.

Genus *Lithosphaeridium* Davey & Williams 1966

Lithosphaeridium siphoniphorum (Cookson & Eisenack)

(Figure 5, O)

Hystrichosphaeridium siphoniphorum Cookson & Eisenack 1958, p. 44, Pl. 11, fig. 10.

Hystrichokolpoma sp. A. Baltes 1963, p. 587, Pl. 6, fig. 1-5.

Hystrichokolpoma sp. B. Baltes 1963, p. 587, Pl. 6, fig. 6-8.

Hystrichosphaeridium siphoniphorum Cookson & Eisenack; Cookson & Hughes 1964 p. 48, Pl. 9, fig. 15.

Lithosphaeridium siphoniphorum (Cookson & Eisenack); Davey & Williams 1966, p. 79, Pl. 7, fig. 7, 8.

Comment. *L. siphoniphorum* has been recorded from a considerable number of ?Cenomanian to Albian deposits in Western Australia. The specimen figured herein, from the Gingin Brook Bore 4 between 404 and 414 feet, agrees closely with the one from the Gingin area (Seismic Shot Hole B2 at 230 feet) originally illustrated by Cookson and Eisenack 1958, Pl. 11, fig. 10. The surface of the Australian specimens is finely and closely granular, not reticulate as in the British examples (Davey & Williams 1966, p. 80).

Dimensions. Shell 28-40 μ in diameter, overall diameter 47-76 μ .

Genus *Cleistosphaeridium* Davey, Downie, Sarjeant and Williams 1966

Cleistosphaeridium ancoriferum (Cookson & Eisenack) emend.

(Figure 6 A-G)

Hystrichosphaeridium ancoriferum Cookson & Eisenack 1960, p. 8, Pl. 2, fig. 11.

Hystriosphæridium ancoriferum Cookson & Eisenack; Cookson & Hughes 1964, p. 4, Pl. 9, fig. 7.

Cleistosphaeridium ancoriferum (Cookson & Eisenack); Davey, Downie, Sargeant & Williams 1966, p. 167, Pl. 6, fig. 5, Pl. 9, fig. 1.

Age and Occurrence. *C. ancoriferum* was earlier recorded from a number of Western Australian Albian-Cenomanian deposits. These include the lower part of the Gearle Siltstone, Rough Range South Bore 1 at 2748-2758 feet, Wapet's Seismic Shot Hole B1 at 210 and 220 feet north of Gingin and the Osborne Formation in the Perth area.

Comment. Specimens referable to *C. ancoriferum* are not uncommon in the sample from Gingin Brook between 404 and 414 feet. Such examples are particularly well-preserved and under an oil immersion lens have shown details regarding the structure not noticed during our original investigation of this form. The occurrence of these new features led to a re-examination of the holotype of *C. ancoriferum* (Fig. 6B) with the result that the emended description which follows, based on the original holotype and the new specimens from the Gingin Brook deposit, is now necessary.

Emended Description. Shell spherical, relatively small, with numerous (more than 50) relatively short, somewhat broadly-based appendages which are almost straight sided or slightly narrowed distally. The appendages are hollow, distinctly septate with a surface ornament of minute, irregular or dot-like projections (Fig. 6, C and G); at the apex of each appendage a slight widening results in a somewhat V-shaped appearance (Fig. 6G) and the whole apex is enveloped in a thin, smooth, roughly circular "cap", the edges of which curve slightly backwards towards the shell (Fig. 6C, G). The enlarged apices are quite often in direct contact with one another, while others are free (Fig. 6D, F). Whether the former is the natural position and the apices are connected by a continuous membrane, or whether their frequent apparent freedom results from the chemical treatment to which the shells have been subjected, it is impossible to tell. Certain it is that no membrane similar to that present in the genus *Chlamydophorella* (Fig. 6H) is represented in *C. ancoriferum*.

Dimensions. Holotype (Fig. 6B) overall diameter c. 70 μ , shell c. 52 μ ; figured specimen (Fig. 6A) overall diameter c. 60 μ , shell c. 42 μ .

Comment. As far as can be judged from the illustrations given by Davey, Downie, Sargeant & Williams (Pl. 6, fig. 5; Pl. 9, fig. 1), the specimens from the Fletcham Hill Borehole, Surrey, England appear to have little in common with the Australian species. So far an archeopyle has not been evident in the many Australian examples observed.

Family CYCLONEPHELIACEAE Eisenack

Genus *Cyclonephelium* Deflandre & Cookson 1955
emend Cookson & Eisenack 1962 and Williams and Downie 1966

Cyclonephelium distinctum Deflandre & Cookson
(Figure AF)

Cyclonephelium distinctum Deflandre & Cookson 1955, p. 285 Pl. 2, fig. 14.

Cyclonephelium distinctum Deflandre & Cookson; Gocht 1958 vol. 3, p. 77, Pl. 4, figs. 16-18.

Circulodinium deflandrei Alberti 1961, p. 293, Pl. 4, figs. 7-13.

Cyclonephelium distinctum Deflandre & Cookson; Cookson & Eisenack 1962, p. 495, Pl. 4, fig. 11.

Comment. *C. distinctum* has already been recorded (Cookson & Eisenack 1962) from a relatively large number of Western Australian deposits, which range in age from Albian (Lower Gearle Siltstone, Wapet's Rough Range South Bore No. 1 between 2860 and 2867 feet) to probably Turonian and Mid-Senonian (north of Gingin, Wapet's Seismic Shot Hole B1 at 160 feet. *C. distinctum* has occurred frequently in preparations of the silty limestone Gingin Brook Bore 4 between 404 and 414 feet.

Cyclonephelium membraniphorum Cookson & Eisenack 1962

(Figure 5L)

Cyclonephelium compactum Deflandre & Cookson 1955; Cookson & Eisenack 1958, p. 48, Pl. 12, fig. 8.

Cyclonephelium membraniphorum Cookson & Eisenack 1962, Pl. 6, fig. 8-14.

Comment. Examples resembling those of *C. membraniphorum* from a large number of Albian to ?Cenomanian deposits in Western Australia, including one from the Gingin area, Wapet's Seismic Shot Hole B1 at 200-210 feet (Cookson & Eisenack 1962, p. 495) have been recovered from the Gingin Brook No. 4 Borehole, between 404 and 414 feet.

Family Uncertain

Genus *Coronifera* Cookson & Eisenack 1958

Coronifera oceanica Cookson & Eisenack 1958

(Figure 6K)

Coronifera oceanica Cookson & Eisenack 1958, p. 45, Pl. 12, fig. 5, 6.

Coronifera oceanica Cookson & Eisenack; Cookson & Hughes 1964, p. 56, Pl. 9, fig. 8, 9.

Comment. Only one example of *C. oceanica* has so far been recovered from the Gingin Brook Bore 4, between 404 and 414 feet. It is of special interest since it is the only one so far found in which an archeopyle has been developed and the orientation of the shell determinable. Although this example is somewhat obliquely presented, there is little doubt that the archeopyle is apical and the single large tubular horn, characteristic of the genus *Coronifera*, antapical.

This specimen is densely covered with rather long, flexible, hair-like appendages. It is closer in general features to the examples from the Cambridge Greensand than to the holotype, in which a stiff spine was recorded as present at the end opposite the horn.

Dimensions. Shell c. 58 μ long and c. 52 μ broad; overall length c. 95 μ , overall breadth c. 94 μ , antapical horn c. 24 μ long, appendages c. 14-16 μ long.

Genus *Hexagonifera* Cookson & Eisenack 1961

Hexagonifera chlamydata Cookson & Eisenack 1962

Hexagonifera chlamydata Cookson & Eisenack 1962, p. 496, Pl. 7, fig. 1-3, 5-8.

Hexagonifera chlamydata Cookson & Eisenack; Cookson & Hughes 1964, p. 61, Pl. 10, fig. 7-9.

Comment. Well-preserved and typical examples of *H. chlamydata* have been recovered

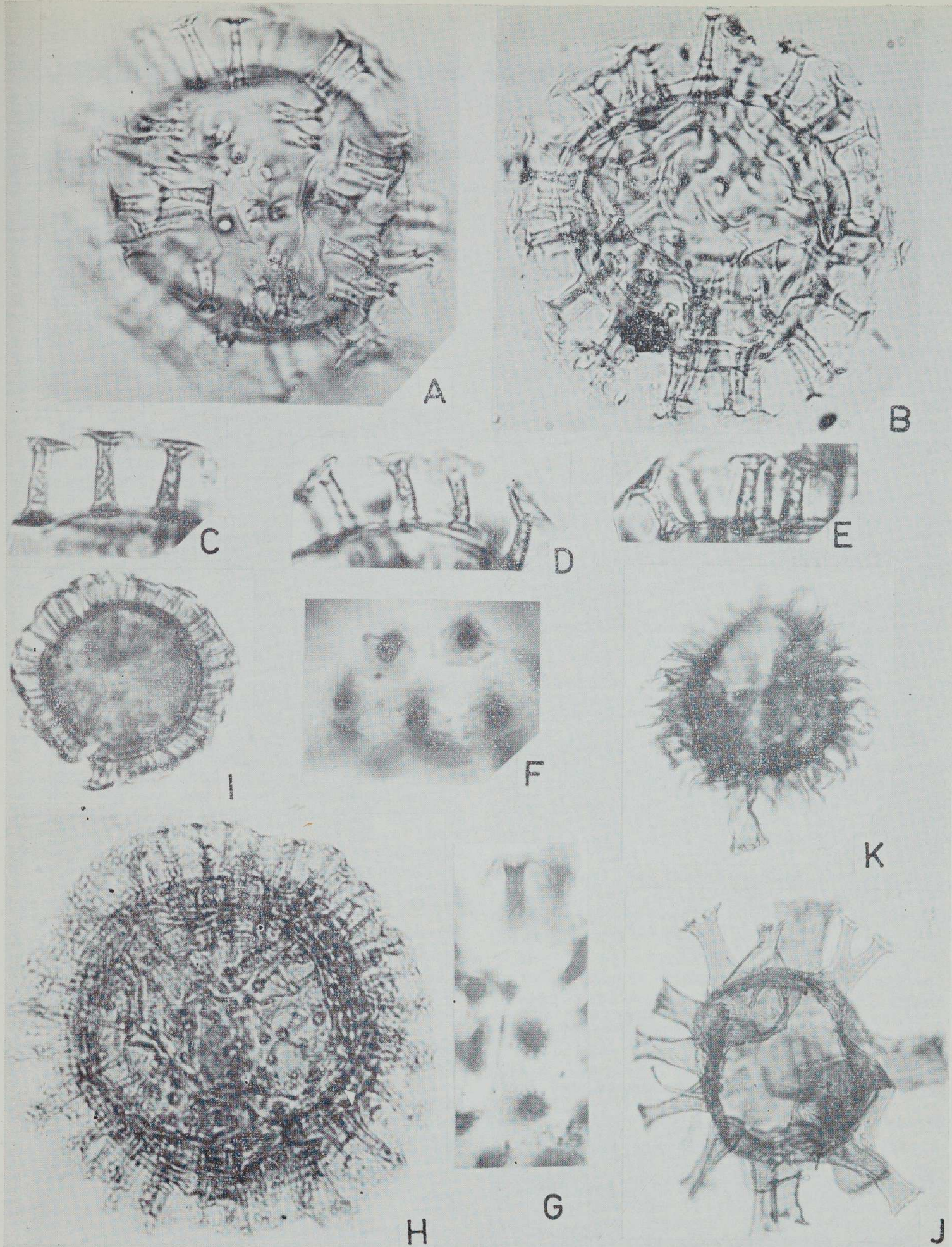


Figure 6. A.—*Cleistosphaeridium ancoriferum* (Cookson & Eisenack) X c. 1,000. B.—*Cleistosphaeridium ancoriferum* holotype X c. 1,000. C, D, E, F.—*Cleistosphaeridium ancoriferum* showing detailed structure of appendages in side view and optical section X c. 1,300. G.—*Cleistosphaeridium ancoriferum*. Portion of the wall showing the V-shaped terminal portion of one appendage and the surface ornamentation of two others viewed from above X c. 1,300. H.—*Chlamydophorella nyei* Cookson & Eisenack, Roma Formation, North Queensland, Paratype showing the dotted membrane which encloses shell and appendages X c. 1,500. I.—*Chlamydophorella nyei* Cookson & Eisenack from Gingin Brook Bore 4, 404-406 feet, X c. 700. J.—*Hystrichosphaeridium stellatum* Maier X c. 500. K.—*Coronifera oceanica* Cookson & Eisenack X. c. 500.

from the Gingin Brook core 4 between 404 and 414 feet. All have shown the outer hyaline membrane which envelops the shell.

Genus *Chlamydophorella* Cookson & Eisenack 1958

Chlamydophorella nyei Cookson & Eisenack 1958

(Figure 6I, refigured paratype figure 6H)

Chlamydophorella nyei Cookson & Eisenack 1958, p. 56, Pl. 11, fig. 1-3.

Chlamydophorella nyei Cookson & Eisenack; Cookson & Eisenack 1962, p. 496, Pl. 7, fig. 14-16.

Chlamydophorella nyei Cookson & Eisenack; Cookson & Hughes 1964, p. 54, Pl. 1, fig. 12.

Chlamydophorella nyei Cookson & Eisenack; Manum & Cookson 1964, p. 18, Pl. 5, fig. 3.

Comment. Examples of *C. nyei* have occurred in the Gingin Brook sample from Bore 4 at 404-414 feet. In order to show the detailed structure of this form more clearly than was hitherto possible, a photograph of the Paratype of *C. nyei* taken under oil immersion is given on Figure 6H.

Group ACRITARCHA Evitt 1963

Subgroup POLYGONOMORPHITAE

Genus *Veryhachium* Deunff 1954 emend Downie & Sarjeant 1962

Veryhachium reductum (Deunff)

(Figure 5P)

Veryhachium trisulcum Deunff var. *reductum* Deunff 1959, vol. 2, p. 27, Pl. 1, fig. 8-11.

Veryhachium reductum (Deunff); Jekhowsky 1961, p. 210-212, Pl. 2, figs. 22-37.

Veryhachium reductum (Deunff); Brosius & Bitterli 1961, p. 36, Pl. 1, fig. 3-6.

Veryhachium reductum (Deunff); Cookson & Eisenack 1962, p. 492, Pl. 4, fig. 16.

Veryhachium reductum (Deunff); Cookson & Hughes 1964, p. 56, Pl. 11, fig. 8.

Comment. *Veryhachium reductum* has occurred regularly in preparations of the Gingin Brook sample from Bore 4 between 404 and 414 feet. It was earlier recorded (Cookson & Eisenack 1962) as of common occurrence in the Osborne Formation in the Perth area and Gingin areas and the Carnarvon Basin, Western Australia of ?Albian-Aptian to Cenomanian age. *V. reductum* was noticeably absent from the younger of the two Gingin Brook Bore 4 samples, namely the silty limestone at 202-204 feet considered earlier in this paper.

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